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Management of Offshore Wastes in the United States

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ABSTRACT

During the process of finding and producing oil and gas in the offshore environment, operators generate a variety of liquid and solid wastes. Some of these wastes are directly related to exploration and production activities (e.g., drilling wastes, produced water, treatment, workover, and completion fluids) while other types of wastes are associated with human occupation of the offshore platforms (e.g., sanitary and domestic wastes, trash). Still other types of wastes can be considered generic industrial wastes (e.g., scrap metal and wood, wastes paints and chemicals, sand blasting residues). Finally, the offshore platforms themselves can be considered waste materials when their useful life span has been reached. Generally, offshore wastes are managed in one of three ways – onsite discharge, injection, or transportation to shore. This paper describes the regulatory requirements imposed by the government and the approaches used by offshore operators to manage and dispose of wastes in the United States.

INTRODUCTION

The United States has been a world leader in producing oil and gas from offshore platforms. The process of exploration and production (E&P) of oil generates numerous types of wastes that must be disposed, recycled, or otherwise managed. Offshore waste management practices have evolved through U.S. requirements and international agreements. In the United States, offshore oil and gas companies have three main options for waste disposal – discharge to the sea, underground injection or encapsulation, and onshore disposal. A fourth option, incineration, has rarely been used.

The U.S. government does not dictate a specific disposal option that the operator must use. The U.S. legal system establishes requirements for each disposal option, and companies decide for themselves which of the options they will follow. Numerous potential waste management options exist, but many potential options are precluded by regulatory requirements. For example, it is technically and economically possible to dispose of oil-based drilling fluids by discharging them to the sea, but the U.S. Environmental Protection Agency (EPA) prohibits the practice. Therefore, that potential option is eliminated from further consideration. Many other potential options must be discarded for legal or technical reasons. Offshore operators are then left with a reduced list of legal and technically feasible options. Operators then choose from these waste management options by consideration of total costs. The total costs include capital costs, operating and maintenance costs, transportation costs, and potential future liability costs. Liability costs arise when a chosen option results in future environmental restoration costs,

such as those imposed under the Superfund law, or in future health and safety costs. This paper discusses the types of wastes generated at offshore platforms and the U.S. regulatory requirements that govern their disposal. Information is presented on how selected U.S. operators manage their offshore wastes.

TYPES OF OFFSHORE WASTES

E&P Wastes

The wastes most commonly thought of as offshore wastes are those associated with offshore E&P. These wastes include:

- drilling fluids
- drill cuttings
- produced water
- treatment, workover, and completion fluids
- deck drainage
- produced sand
- naturally occurring radioactive materials (NORM)
- hydrostatic test water
- other assorted wastes

Human-Derived Wastes

Human-derived wastes are associated with basic human activities on offshore facilities, and include:

- sanitary wastes
- domestic wastes (kitchen wastes, laundry wastes, sinks, and showers)
- trash.

Other Industrial Wastes

A variety of wastes that are not specific to the offshore oil and gas industry are also generated at offshore facilities. These could be found at numerous other industrial facilities. They include, for example:

- scrap metal
- wood pallets
- cardboard
- empty drums
- used chemicals and paint
- sandblasting grit and paint
- cooling water

Decommissioned Platforms

The final category of offshore waste is not a traditional waste but consists of the platforms themselves. At the end of the useful life span of the platforms, they must be removed from service and somehow disposed of.

REGULATORY REQUIREMENTS FOR OFFSHORE WASTES

Several U.S. government agencies cooperatively regulate offshore waste management activities. The Minerals Management Service (MMS) has responsibility for overseeing oil and gas extraction activities on the Outer Continental Shelf, including activities on offshore platforms (except for discharges of wastes to the sea) and underground injection or encapsulation of offshore wastes. The EPA has responsibility for regulating discharges of offshore wastes to the sea. The MMS conducts inspections of offshore discharges for the EPA in some locations. The U.S. Coast Guard has responsibility for documenting and responding to spills of oil and hazardous materials from offshore activities, but that is not the subject of this paper. If offshore wastes are brought onshore for disposal, state agencies take over the responsibility for regulating waste management and disposal. In the following sections, requirements for each type of waste disposal are discussed.

Discharges to the Sea

NPDES Permits - The primary U.S. law affecting water quality and water pollution control is the Clean Water Act. The Clean Water Act requires that all discharges of pollutants to surface waters (streams, rivers, lakes, bays, and oceans) must be authorized by a permit issued under the National Pollutant Discharge Elimination System (NPDES). Discharges not authorized by an NPDES permit are illegal. Individual NPDES permits can be issued to separate activities or general NPDES permits can be issued that cover all similar activities located in the same geographic area. For offshore oil and gas operations, EPA normally issues general permits for broad areas such as the Western Gulf of Mexico, Eastern Gulf of Mexico, North Slope, Alaska, or Cook Inlet, Alaska.

The heart of an NPDES permit is its numerical effluent limits. These limits describe what pollutants must be monitored and what is an acceptable quantity or concentration of the pollutants. Effluent limits are developed by considering technology-based limits (based on applicable effluent limitations guidelines or ELGs) and water quality-based limits.

ELGs - ELGs are national technology-based discharge requirements. These standards are developed by EPA on an industry-by-industry basis, and represent the greatest pollutant reductions that are economically achievable for an industry sector or portion of the industry (e.g., offshore oil and gas platforms). Selection of ELGs involves consideration of technologies that have already been demonstrated in industrial applications, costs and economic impacts, and non-water quality environmental impacts.

The ELGs are applied uniformly to every facility within the industrial sector, regardless of where in the country the facility is located or the condition of the water body receiving the discharge.

EPA has developed ELGs for most major industrial categories. For the oil and gas industry, EPA developed separate ELGs for offshore, coastal, and onshore areas. Oil and gas activities located onshore and in coastal waters[1] (except for Cook Inlet, Alaska, which is treated in the same manner as offshore waters) may not discharge drilling wastes or produced water to the marine environment. In most cases, offshore oil and gas facilities are allowed to discharge these wastes to the sea. The ELGs for discharges in offshore waters are shown in Table 1.

Water quality-based limits - The Clean Water Act does not prohibit discharges of materials that can be considered toxic, like metals and organic chemicals. Instead, the Clean Water Act prohibits the discharge of toxic substances in toxic quantities. This goal is accomplished through water quality-based effluent limits that make sure ambient receiving water concentrations are low enough to maintain the designated use of the waters (for example, fishing).

ELGs serve as a foundation for the effluent limits included in a permit, but the ELGs are based on the performance of a technology and do not address the site-specific environmental effects of discharges. In certain instances the technology-based controls may not be strict enough to ensure that the aquatic environment will be protected against toxic quantities of substances. In these cases, EPA must include additional, more stringent water quality-based effluent limits in NPDES permits. These water quality-based limits may be numeric (EPA has published numeric water quality criteria for more than 100 pollutants that can be used to calculate water quality-based limits) or narrative (for example, "no toxic substances in toxic quantities"). The procedures for setting these limits take into account the designated use of the water body, the variability of the pollutant in the effluent, species sensitivity (for toxicity), and where appropriate, dilution in the receiving water (discharge conditions, water column properties).

Waste streams not covered by ELGs - Not all types of offshore wastes are covered by the ELGs (those wastes covered by the ELGs are shown in Table 1), but all wastes discharged from the platform must be included in the NPDES permit. For example, wastes such as cooling water, boiler blowdown, ballast water, and others are not mentioned in the ELGs but the general permits authorize discharge of these wastes. The permit writer calculates limits for these other types of wastes on the basis of best professional judgement.

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[1]The terms onshore, coastal, and offshore can be confusing. As a simple definition, consider an imaginary line running along the coast of a country. The line crosses the mouth of rivers, bays, and inlets. Any facility to the ocean side of the line is defined as an offshore facility. Any facility to the land side of the line and located on land is classified as an onshore facility. Any facility located in or on the water or in wetlands on the land side of the line, is defined as a coastal facility. (For example, a facility located in a marsh or inside a river mouth or bay is considered to be coastal.)

Other NPDES permit conditions - To a large extent, facilities are responsible for taking the steps necessary to demonstrate compliance with NPDES permit limits. Permits instruct each facility operator on the frequency for collecting wastewater samples, the location for sample collection, the pollutants to be analyzed, and the laboratory procedures to be used in conducting the analysis. Detailed records of these "self-monitoring" activities must be retained by the facility for at least three years. Furthermore, each facility is required to submit the results of these analyses to EPA on a periodic basis. For most facilities, the reporting frequency is monthly or quarterly, but in no case may it be less than once per year. Inspectors from EPA or the MMS visit the offshore platforms occasionally to monitor their discharges and make sure that all operations are in compliance with permit requirements. Failure to meet the permit limits can result in fines or loss of the permit.

NPDES permits may also include operational or environmental effects monitoring requirements. Examples of these include: preparing best management practices plans (they outline good operating practices) or spill prevention plans; submitting an inventory of additives to drilling fluids; and conducting additional monitoring of the discharges, sediments, or fish tissues.

E&P wastes that cannot be discharged - Some types of E&P wastes cannot be discharged. These include oil-based drilling fluids and cuttings, produced sand, and NORM sludge and scale. The prohibition on NORM disposal does not apply to the NORM present in produced water.

Ocean Discharge Criteria Evaluation - Discharges made directly to the ocean must undergo an additional level of review to ensure that they do not cause unreasonable degradation to the marine environment. Before issuing an NPDES permit for offshore discharges, EPA must consider factors such as:

- the quantities, composition and potential for bioaccumulation or persistence of the pollutants to be discharged;
- the potential transport of such pollutants by biological, physical or chemical processes;
- the biological communities that may be exposed to such pollutants;
- the importance of the receiving water area to the surrounding biological community, including the presence of spawning sites, nursery areas, and migratory pathways;
- the existence of special aquatic sites such as marine sanctuaries and refuges, parks, national and historic monuments, national seashores, wilderness areas and coral reefs;
- the potential impacts on human health;
- existing or potential recreational and commercial fishing; and
- numeric water quality criteria for specific pollutants.

NPDES permits for facilities discharging into marine waters are required to include limits, including a discharge prohibition if necessary, that prevent unreasonable degradation of the marine environment. If not enough information is available to determine whether the discharge will cause unreasonable degradation, EPA determines whether the discharge will cause irreparable harm to the marine environment and whether there are reasonable alternatives to on-site disposal. In assessing the potential for irreparable harm, EPA determines whether the facility is likely to cause permanent and significant harm to the environment during a monitoring period in which additional information is gathered. If potential for irreparable harm is low, EPA may allow a monitoring program to demonstrate that the discharge will not cause unreasonable degradation. If data gathered through monitoring indicate that continued discharge may cause unreasonable degradation, the discharge must be halted or additional permit limitations established.

Environmental Impact Statements and Environmental Assessments - The National Environmental Policy Act requires federal agencies to consider the environmental impacts of proposed actions. When issuing a permit for new offshore oil and gas E&P facilities, EPA must develop an Environmental Assessment (EA) or, if impacts may be significant, an Environmental Impact Statement (EIS). Sometimes EPA and MMS jointly prepare these documents. The EIS must consider short term and long term effects, direct and indirect effects, and beneficial and adverse environmental impacts of the proposed activity. MMS may add additional mitigation measures on discharges when the EIS or EA determines there may significant impacts on resources of concern.

The MMS, through its Studies Program, performs research and monitoring dealing with the environmental effects of offshore oil and gas exploration, development, and production. The results of these studies are used in the EISs.

Underground Injection or Encapsulation

In U.S. offshore areas, companies may inject E&P wastes that originate on the Outer Continental Shelf into injection wells or encapsulate them in the well bore of wells that are about to be abandoned. Each application for underground waste disposal must be authorized on a case-by-case basis by the MMS. The general MMS requirements for underground injection of wastes are described below.

Injection Wells - If companies inject wastes through underground injection wells, the formation receiving the wastes must be located below the deepest drinking water aquifer, must be isolated above and below by shale layers, and may not contain any producing wells. Companies must demonstrate that injection wells have mechanical integrity (they do not leak fluids into formations other than those that are intended to receive the fluids).

Encapsulation - Companies may use two different types of encapsulation. In the first type, wastes are placed directly in the well bore of a well that is being abandoned. In the second type, wastes are placed into a section of pipe, caps are put on both ends, and the pipe section is lowered into the well bore. In either case, the wells selected to receive the wastes must not be intersected by faults that extend upward to the sea floor and must not be located in an area with mud flows, slumps, or slides. The top of the encapsulated

waste must be located at least 1,000 feet (300 meters) below the sea floor. A cement plug of at least 200 feet (60 meters) must be placed above and below the encapsulated waste.

Alaskan Wells - On the North Slope of Alaska, E&P wastes are injected underground. In Cook Inlet, Alaska, oil-based drilling waste and sewage are injected. All current platforms in Alaska are located close to shore, in locations regulated by the state of Alaska, rather than in far offshore locations regulated by the MMS. The Alaskan requirements are similar to those imposed by the MMS but they include more detailed requirements for construction and monitoring of the injection wells. Any underground disposal of NORM in Alaska must be done by encapsulation in sealed pipe sections.

Onshore Disposal

Although many types of offshore wastes can legally be discharged to the sea, companies bring some types of wastes back to shore for disposal. Some types of E&P wastes, such as oil-based drilling fluids and cuttings, produced sand, or NORM sludge and scale, are prohibited from discharge by the permits. Other wastes, such as some types of water-based drilling fluids and cuttings and some treatment workover, and completion fluids, may not meet the permit's effluent limits and, therefore, cannot be discharged.

The U.S. law for management of most types of waste is the Resource Conservation and Recovery Act (RCRA). This law specifically exempts E&P wastes from consideration as hazardous wastes. This is a legal determination and does not necessarily reflect the chemical nature of the wastes. RCRA places no specific requirements on E&P wastes, but leaves the authority to regulate these wastes to the individual states. Most U.S. states follow the federal hazardous waste exemption for E&P wastes. One state that receives offshore wastes, California, has regulations that require each batch of waste to be chemically and physically tested to determine if the waste should be classified as a hazardous waste. Wastes that are hazardous are subject to much stricter and more expensive disposal requirements. Another state receiving offshore wastes, Louisiana, requires testing of most offshore wastes brought onshore.

Most E&P wastes that come onshore in the Gulf of Mexico are brought to shore bases in Texas and Louisiana. They are then transferred to onshore commercial treatment and disposal facilities that use primarily land spreading to dispose of the wastes, or treatment of the waste and injection of the resulting liquids into injection wells. Onshore disposal costs in the Gulf of Mexico region (not including transportation) are commonly in the range of $8-$11/bbl (1). Some state regulations require that each shipment of E&P wastes be tracked by a manifest system from the time it leaves the offshore platform until final disposal.

Trash and other industrial wastes generated at offshore platforms may not be discharged and must be brought back to shore for disposal. This prohibition comes from MARPOL 73/78 (2) and from U.S. Coast Guard regulations. Operators haul these wastes to shore bases where they are then sent to onshore disposal facilities. Trash is sent to a local sanitary landfill, nonhazardous industrial wastes are sent to industrial waste facilities, and hazardous wastes are sent to hazardous waste facilities. Some NORM is injected

offshore but most is brought to shore for disposal at a commercial injection well facility where the disposal cost is approximately $150/bbl (2).

Most operators have developed comprehensive waste management plans, waste minimization programs, and recycling programs on the platforms and at the shore bases. Some differences exist in waste management practices between geographical regions because of extreme climatic conditions, lack of shore-based infrastructure, and regional air management requirements.

MANAGEMENT OF DECOMMISSIONED PLATFORMS

When offshore platforms have reached the end of their useful life they must be removed from the production site. Unlike the North Sea, where platform disposal has generated a heated political debate, in the Gulf of Mexico approximately 90% of the platforms are brought to shore where they are either refitted or turned into scrap. The remaining 10% of platforms are moved to locations where they can be sunk to create artificial fishing reefs, a valuable resource. The States of Texas and Louisiana both operate "Rigs to Reefs" programs under which sinking of the old platforms can be done with proper controls. In Texas, 31 artificial reefs have been created.

ACTUAL U.S. OFFSHORE WASTE DISPOSAL PRACTICES

Information was collected from several major U.S. offshore operators concerning their actual disposal practices. Table 2 outlines the practices of three companies operating in the Gulf of Mexico. In general, most wastes authorized for discharge to the sea are discharged with nearly all of the rest being brought to shore for disposal. Injection of E&P wastes occurs only occasionally in the Gulf of Mexico.

On the North Slope of Alaska, current offshore activities are located near shore. E&P wastes are all injected. Sanitary and domestic wastes are discharged. Trash is hauled to shore where paper, metal, and styrofoam are recycled and the remainder goes to a local government waste disposal facility. Projects located farther offshore are now being developed. At those facilities, trash will be incinerated and all other solid and liquid wastes will be ground and injected. An NPDES permit will be obtained solely for emergencies.

In Cook Inlet, Alaska, operators discharge most types of wastes authorized for discharge. Treated sewage and oil-based cuttings are injected. Other wastes are segregated at the platform and brought to shore for disposal. Trash is taken to a local landfill. Those E&P wastes that could not be discharged, including NORM wastes, are shipped to the lower 48 states for disposal.

In California, operators discharge most types of wastes authorized for discharge. Small volumes of drilling wastes and treatment, workover, and completion fluids are

disposed through annular injection. Other types of wastes are brought to shore and disposed of in accordance with State rules. In California, E&P wastes are not automatically exempt from hazardous wastes status under RCRA so each batch of wastes must be tested. Operators are required to develop wastes minimization plans.

Except for the proposed offshore facilities on the North Slope of Alaska, the actual disposal practices for trash and industrial wastes are similar in all regions. Different types of wastes – hazardous, nonhazardous, and trash – are segregated on the platforms. Recycling is practices wherever possible. These wastes are brought to the companies' shore bases where they are sent to specific disposal companies based on the types of wastes.

CONCLUSIONS

U.S. offshore oil and gas operators have a variety of waste management options. The U.S. regulatory structure is mature and is reasonably well understood by major operators. Wastes are discharged to the sea when in compliance with permits and other regulatory requirements. Those wastes that cannot be discharged are injected or are brought to shore for disposal. The industry has developed an effective infrastructure for collection, transportation, and onshore disposal of wastes that are not suitable for on-site discharge or injection.

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Table 1 - U.S. Offshore ELGs (from Code of Federal Regulations, Title 40, Part 435, Subpart A)

Drilling Fluids and Drill Cuttings

a. Facilities located from 0-3 miles from shore, except those in Alaska, may not discharge drilling fluids and drill cuttings

b. Facilities located more than 3 miles from shore and all Alaskan offshore facilities may discharge drilling fluids and drill cuttings but must meet the following restrictions:

- No discharge of free oil or diesel oil is allowed [this effectively prohibits the discharge of oil-based fluids and cuttings]

- The 96-hour LC50 (the concentration at which one half of the test organisms die during a 96-hour toxicity test) must be at least 30,000 parts per million

- The barite component used to make the drilling fluid (not the whole drilling fluid) must not contain more than 1 mg/kg mercury and 3 mg/kg cadmium

Produced Water

- Produced water may be discharged to offshore waters and water of Cook Inlet, Alaska, if the concentration of total oil and grease does not exceed a monthly average of 29 mg/L or a daily maximum of 42 mg/L

Treatment, Workover, and Completion Fluids

- Same as produced water

Produced Sand

- No discharge allowed

Deck Drainage

- Discharges are allowed but they may not contain free oil [may not cause an oil sheen]

Sanitary and Domestic Waste

- Discharges are allowed but they may not contain floating solids
- Facilities located 0-12 miles from shore - no food waste may be discharged
- Facilities located more than 12 miles from shore - can discharge food waste if it is ground up small enough to pass through a 25-mm mesh screen

Table 2 - Actual E&P and Human Waste Disposal Practices in the Gulf of Mexico from Three U.S. Majors

Waste	Company A	Company B	Company C
Water-based muds	All discharged	Most discharged	All discharged
Oil-based muds	Recycled	Recycled	Recycled
Synthetic-based muds	Recycled	Recycled	Recycled
Water-based cuttings	All discharged	Most discharged	All discharged
Oil-based cuttings	All onshore	All onshore	All onshore
Synthetic-based cuttings	All onshore	Most discharged	All discharged
Produced water	All discharged	All discharged	All discharged
Produced sand	All onshore	All onshore	All onshore
Treatment, workover and completion fluids	60% discharged; 40% onshore	Some discharged; some offshore	Most discharged
Domestic waste	All discharged	All discharged	All discharged
Sanitary waste	All discharged	All discharged	All discharged
NORM	All onshore	All onshore	All onshore